

# Chapter 19

## Direct Participants' Behavior Through the Lens of Transactional Analysis: The Case of SPEI<sup>®</sup>

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**Abstract** This paper presents a methodology to study the flow of funds in large value payment systems (LVPSs). The presented algorithm separates the flow of payments in two categories: (1) external funds, i.e. funds transferred from other financial market infrastructures (FMIs) or provided by the central bank and (2) the reuse of incoming payments. Our method further studies the flow of intraday liquidity under the framework of its provision within the Mexican FMIs. The aim is to evaluate the impact of the intraday liquidity provision, and understand how liquidity is transmitted to participants in the Mexican LVPS SPEI<sup>®</sup>.

### 19.1 Introduction

The worldwide economic crisis has revealed that liquidity problems of (large) banks can occur suddenly, and with serious consequences for the (global) financial stability. The Lehman Brothers' collapse in 2008 is the most recent and widely referred to example. The interest, by both academics and financial authorities (such as central banks), in intraday liquidity management has gained momentum since then. Studying intraday liquidity flows, gives valuable insight into: (1) the provision of liquidity and the level of efficient use, (2) potential liquidity risks in settling payment obligations, and (3) the degree of interdependencies between financial

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market infrastructures (FMIs) in terms of liquidity, in particular between the large value payment and securities settlement systems (LVPSs and SSSs). Central banks can use this insight to improve the intraday liquidity provision, to enhance the legal documentation of FMIs and to improve the implementation of the Principles of Financial market Infrastructures (PFMIs, see [1]).

To smoothen settlement of transactions in the FMIs, central banks provide (intraday) liquidity to participants in their LVPS. This liquidity together with liquidity from their payment obligations flow through different FMIs. Then liquidity is redistributed among participants either as transfers, payment obligations or secured/unsecured lending/borrowing among them. By studying liquidity flows central banks gain insight in the emerging network among participants revealing the structure of interdependency among financial institutions. Given that some of these institutions are direct participants in more than one FMI, the overall network of funds transfers among FMIs must be taken into account. Furthermore, central banks obtain information on the behavior of the participants related to the intraday liquidity management, i.e. the decisions during the day with respect to the number/value of payment obligations. We have identified three factors affecting the decision on how many payment orders will be sent for settlement by a participant throughout the day: (1) the amount of central bank money this participant has access to, (2) the amount of funds in terms of borrowing the institution can obtain from other participants, if required, and (3) the volume of payments received due to existing obligations either towards the participant or to its clients in a particular moment of the day.

Most countries in the industrialized world have implemented real time gross settlement (RTGS) systems (see [2]). In comparison to deferred net settlement (DNS) systems, RTGS eliminate settlement and credit risk that could arise between participants in the netting system. Nevertheless RTGS increase pressure on the level of intraday liquidity used to fulfill payment obligations, for that reason the most analysis on large value payment systems focuses on RTGS systems rather than netting. This paper defines a methodology to study the flow of funds observed in LVPSs related to funds transferred from other FMIs or provided by a central bank (first factor above), and the reuse of incoming payments (the second and third factors above). Under the specific operational rules used by the Mexican LVPS SPEI<sup>®</sup>, an algorithm is developed, using individual transaction data, to distinguish to what extent incoming payments are used to cover obligations. The time-scale of the algorithm is determined by the settlement rules of the system, which is every 3 s. In this study we present different time profiles, which are created under the same frequency of seconds. For more details of the operation framework, please refer to [3]. In comparison to other RTGS, SPEI<sup>®</sup> processes a high volume of transactions in real time settlement—on average 853,000 daily during 2013. From those operation around 91 % correspond to payments with value lower than 10,000 EUR.

The outline of this paper is as follows. Section 19.2 provides a brief literature overview. Section 19.3 describes the three different liquidity related issues: (1) the mechanism of liquidity provision, (2) distinguishing between the use of external funds and incoming payments, and (3) the profiles of daily, weekly and hourly

activities in the Mexican LVPS SPEI<sup>®</sup>. Section 19.4 concludes and gives final remarks.

## 19.2 Literature Review

The focus of this paper is on liquidity flows and intraday patterns in (the Mexican) LVPS. This section reviews recent literature on LVPS flows and pattern, along with further research topics providing insight into FMI (data) analysis.

Armantier et al. [4] seek to quantify how the changing environment in which Fedwire (the largest LVPS of the United States) operates has affected the timing of payment value transferred within the system. They observe several trends in payment timing from 1998 to 2006. After 2000, the peak in payment activity shifts to later in the day. Indeed, post-2000, a greater concentration of payments occurs after 17:00. At the same time, however, several factors have been associated with increased payment activity early in the day, such as (1) the creation of the Continuous Linked Settlement (CLS) Bank, an institution that settles U.S. dollar payments early in the morning, (2) changes to the Clearing House Interbank Payments System's (CHIPS) settlement practices and (3) expanded Fedwire operating hours. Despite these developments, they find that the distribution of payment activity across the day still peaks more in the late afternoon.

Becher et al. [5] investigate the factors influencing the timing and funding of payments in the CHAPS Sterling system (the British LVPS), drawing where appropriate on comparisons with payment activity in Fedwire. Their results show that the settlement of time-critical payments in CHAPS supplies liquidity early in the day. Liquidity can be recycled to fund less urgent payments. CHAPS throughput guidelines also provide a centralized coordination mechanism that essentially limits any tendency toward payment delay. The relatively small direct membership of CHAPS further facilitates coordination, enabling members to maintain a constant flux of payments during the day.

In RTGS systems the liquidity demand is relatively high, due to the fact that each transaction is settled individually, and it is preferable that banks do not (unnecessarily) delay payments, as this will directly have an effect on the liquidity position of their counterparties. Participants choosing to pay after receiving its incoming payments are known as freeriders. Diehl [6] addresses the question of how free riding in LVPSs should be measured properly. He developed several measures for identifying free riding, which can be measured at individual bank level. His analysis shows that a combination of at least two measures is recommended for capturing the effects of free riding. Diehl's results are based on nine important banks in the German part of TARGET (the European LVPS system). The evaluated measures show stable payment behavior of most participants over time. However, his results also show some remarkable regime shifts, which indicate interesting insights about a single participant.

Massarenti et al. [7] studied the intraday patterns and timing of all TARGET2 interbank payments, and the evolution of settlement delay. One of their results shows that the first hour and a half and the last hour are the most crucial times during the system's operating hours, in terms of the numbers of payments processed (opening hours) and value of payments (closing hour). Their analysis provides only a system-wide view and can be used by operators and overseers of central banks.

Heijmans and Heuver [8] looked at the different liquidity elements which can be identified from LVPS transaction data. They developed a method using LVPS transaction data to identify liquidity stress in the market as a whole and at individual bank level. The stress indicators look at liquidity obtained from the central bank (monetary loans), unsecured interbank loans (value and interest rate), the use of collateral and the payments on behalf of their own business and of their clients.

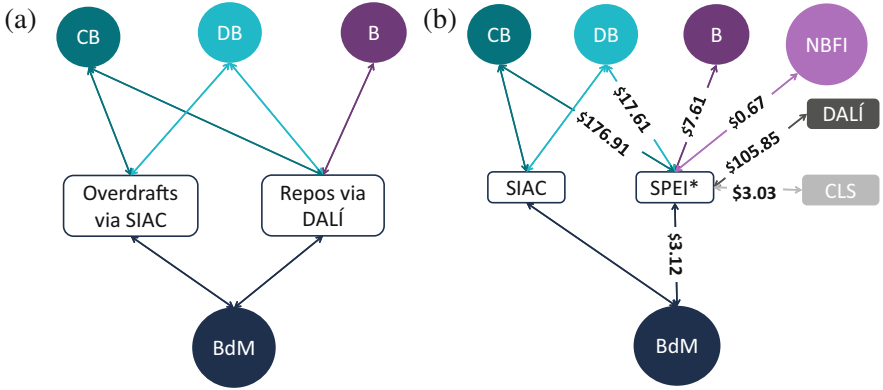
In the case of Mexico, two simulation studies have been conducted by Alexandrova-Kabadjova and Solís-Robleda [3, 9] to analyze the settlement rules of SPEI<sup>®</sup> and the liquidity management of commercial banks that are direct participants. The authors examined the behavior of the selected financial institutions related to the reuse of incoming payments. They found that despite the growing volume of low value payments processed in real time through SPEI<sup>®</sup>, settlement is performed efficiently. Furthermore, the authors argue that observed patterns in the commercial banks' intraday behavior, particularly in the hours low value payments are sent, could be a sign of coordination among participants. However, a study accounting for all direct participants in SPEI<sup>®</sup> has not been done.

All of these papers look at (transaction level) data of one FMI, i.e. in these papers an RTGS system. However, they do not consider operational level per type of direct participants. This paper aims to identify the behavior that characterizes different types of participants in SPEI<sup>®</sup>.

### 19.3 Intraday Liquidity Flows

SPEI<sup>®</sup> is an LVPS and is operated by Banco de México (BdM). It operates under an RTGS scheme [10], as a bilateral and multilateral net settlement process is executed at the latest every 3 s after receiving a new instruction. Low and large value payments between banks and third parties are processed simultaneously in SPEI<sup>®</sup>. The SIAC is system that grant collateralized overdrafts. CLS is the Continuous Linked Settlement system that processes foreign exchange settlements under a Payment versus Delivery (PvD) scheme. DALÍ is a Security Settlement System (SSS) (see [11]).

Figure 19.1a schematically presents the different sectors of direct participants and infrastructures involved in the liquidity provision. Commercial banks (CB) and development banks (DB), which are credit institutions (CI), have access to central bank money in SIAC, as well as accounts in SPEI<sup>®</sup> and DALÍ. Brokerages (B) have accounts in SIAC, SPEI<sup>®</sup> and DALÍ, but do not have direct access to central bank money, whereas other NBFIs have accounts only in SPEI<sup>®</sup>. In addition,



**Fig. 19.1** Intraday liquidity flows. **(a)** Liquidity provision. **(b)** SPEI<sup>®</sup> volume in 2013

credit institutions and brokerages could also obtain intraday liquidity from the BdM through government debt repos, which are carried within DALÍ. Figure 19.1b presents the weighted links that connect SPEI<sup>®</sup> with the following FMIs: (1) SIAC, (2) CLS and (3) DALÍ.

Martinez-Jaramillo et al. [12], Bravo-Benitez et al. [13], and Alexandrova-Kabadjova et al. [14] show how the central bank gives shape to the complex interaction structure to these liquidity channels. The institutions with direct access to liquidity provided by the BdM through SIAC, evaluate in advance the level they need to settle obligations throughout the day in SPEI<sup>®</sup> and DALÍ. Based on these pre-evaluated amounts, they then transfer from their accounts in SIAC to their accounts in SPEI<sup>®</sup>, and use the accounts in SPEI<sup>®</sup> and DALÍ to settle their obligations throughout the day.

### 19.3.1 An Algorithm for Use of External Funds vs. Incoming Payments

Given the time structure of the transactional data in SPEI<sup>®</sup> (semi RTGS), it requires more liquidity than a (Deferred) Net Settlement (DNS) scheme. Nevertheless, payments are settled under bilateral and multilateral netting. For that reason it is important to measure how much this liquidity saving mechanism reduces pressure on the amount of external funds used. Given the high number of retail payments settled during a day, we further assume participants use incoming payments to cover other obligations. This process also reduces the demand for external funds. RTGS share common features around the globe, nevertheless operational and settlement rules and institutional frameworks exhibit significant differences among country. The algorithm we apply for this study is specifically designed for the rules and institutional framework, under which operates SPEI<sup>®</sup>.

The transactional data consists of four elements: time of settlement, institution that send the payment, institution that receive the payment and the amount of the transaction. Payments settled at the same netting cycle have the same time stamp. The algorithm we apply to the transaction data for calculating the level of recycled and externally funded payments in SPEI<sup>®</sup> made by institutions looks as follows: For each cycle:

$$A_{it} = P_{it}^{rec} - P_{it}^{sent} \quad (19.1)$$

$$F_{it} = F_{it-1} - (S_{it-1} + A_{it}), S_{it} = 0, \text{ if } (S_{it-1} + A_{it}) < 0 \quad (19.2)$$

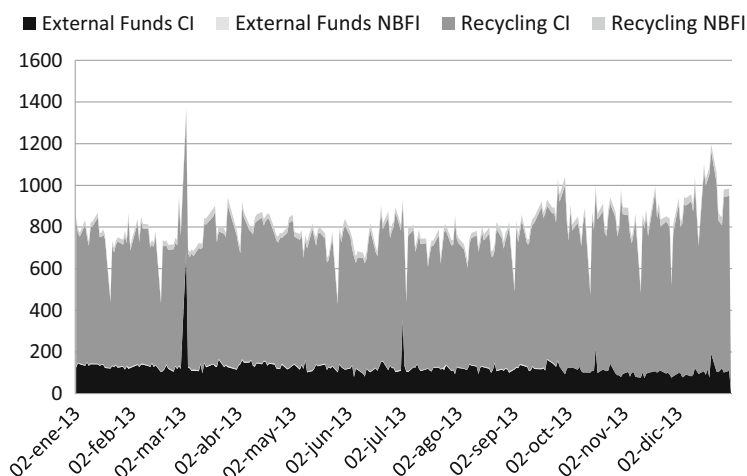
$$S_{it} = (S_{it-1} + A_{it}), \text{ if } (S_{it-1} + A_{it}) \geq 0 \quad (19.3)$$

where  $I$  is the set of participants in SPEI<sup>®</sup> and  $T$  the set of cycles in 1 day. Further,  $P_{it}^{rec}$  and  $P_{it}^{sent}$  are the sum of the incoming and outgoing payment amounts by each  $i \in I$  in each cycle  $t \in T$ , respectively.  $S_{it}$  is the positive balance for each  $i \in I$  in each cycle  $t \in T$ , given that  $S_{i0} = 0$  for all  $i$ .  $F_{it}$  is the amount of funds each  $i \in I$  in each cycle  $t \in T$  has according to the transaction data, given that  $F_{i0} = 0$  for all  $i$ .

$F_{i0}$  and  $S_{i0}$  are set to 0, as the liquidity provision is on a daily basis and does not transfer to the next day.  $S_{it}$  is an auxiliary variable, i.e. it keeps track of the incoming funds that are used to cover other obligations in a way that if there is no availability of such funds, the value of  $S_{it}$  is zero at any time during the day. The value of  $F_{it}$ , which is a cumulative variable, on the other hand represents the overall need of external funds, e.g.  $F_{iD}$  gives the sum of external funding that institution  $i$  really needed during that day, as  $D$  denotes the last settlement period  $t$  in the set  $T$  of settlement cycles for the day. From historical data, we have been able to identify for each real cycle the transactions that have been settled together, such that each cycle  $t$  corresponds to a settlement cycle executed by SPEI<sup>®</sup> with the exact transactions corresponding to that cycle. In Fig. 19.2,  $\sum_{i \in CI} (F_{iD})$  is the daily levels of external funds throughout the year 2013 for the dark grey area, whereas  $\sum_{i \in CI} \sum_{t \in T} P_{it}^{sent} - \sum_{i \in CI} (F_{iD})$  will produce the light grey area, where CI stands for credit institutions, corresponding to the transactions covered with incoming payments by credit institutions. This area is labeled in the figure as “Recycling CI”.

### 19.3.2 Different Time-Scale Profiles of SPEI<sup>®</sup> Participants

Figure 19.2 illustrates the use of external funds vs. incoming payments in SPEI<sup>®</sup>, on a daily basis for 2013. The black and lightest grey areas on the bottom show the need for external funding for CI and NBFI, respectively, whereas the dark grey and medium grey areas on the top show the proportion of incoming payments used to cover outstanding obligations for CI and NBFI. The proportion of the use of incoming payments is calculated as the total payments made by direct participants in SPEI<sup>®</sup> minus the evaluated by the algorithm needed external funding on that



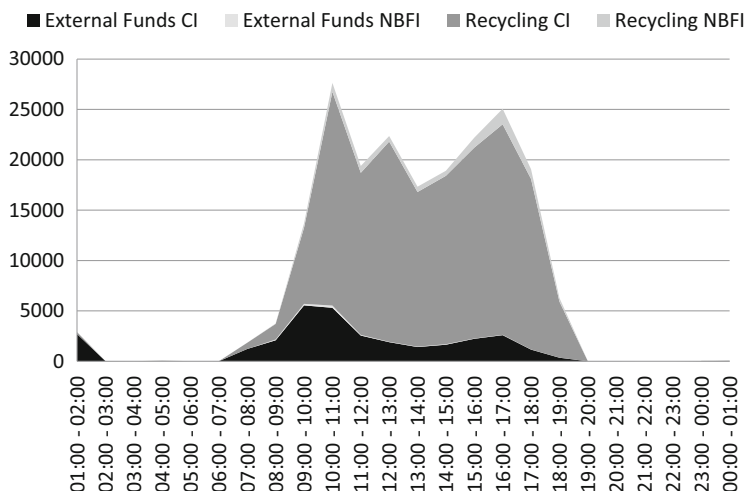
**Fig. 19.2** Daily pattern of funding vs. recycling per type of institutions

day. Overall the percentage corresponding to external funds vs. incoming payments represents 15–85 %, respectively. We further observe that there are two spikes, corresponding to the daily patterns of March 4th and July 2nd for the study period. According to the results presented in [15], the increase in the value of external funds in both cases was used to cover payments initiate by participants and not for third party payments.

Figure 19.3 presents the accumulated hourly profile by type of SPEI<sup>®</sup> participants specifically for CI and NBFi, for the year of 2013. The meaning of colours is the same as in Fig. 19.2. The majority of payments are executed between 7.00 and 20.00 h. However, some payments are made by between 24:00 and 2:00. These payments are related to settlements in CLS and their coordination with the European market.<sup>1</sup>

Further, we observe that the higher volume of externally funded transaction by CI is settled between 9:00 and 12:00 (shown in the figure as the black area). Only Brokerages can get external funds to SPEI<sup>®</sup> for covering their obligations in this system from DALÍ. Nevertheless, this represents a very low volume of the overall transactions in SPEI<sup>®</sup>. For this reason the detailed intraday information, analysed and presented in Fig. 19.3, captures the externally financed obligations in SPEI<sup>®</sup> of NBFIs, as the very thin brightest grey area above the area of external funds used by CI. On the other hand, the internally financed or recycled payments of these institutions are captured by the dark and medium grey areas on the top of the figure. Obligations covered by CI from incoming payments represent the highest volume

<sup>1</sup>The CLS coordinates the transfer of currencies, and related payments appear as transactions between SPEI<sup>®</sup> participants and CLS. The system operates in Mexico between 24:00 and 5:00, which corresponds to 7:00–12:00 Central European Time.



**Fig. 19.3** Hourly pattern of funding vs. recycling per type of institutions

of settled transaction between 8:00 and 19:00, accounting for about 85 % of all transactions. Three peaks of internally financed obligations are observed—at 10:00, at 13:00 and at 18:00. The volume of payments covered by NBFI is stable during the daily hours, with an increase between 15:00 and 18:00 h. The analysis further shows that unsecured lending is taking place in SPEI<sup>®</sup> from CI to NBFI, which implies that the area shown as “Incoming payments NBFI” also includes those transactions and they are costly for the NBFI. In future work, we will focus on extending the methodology towards detection of transactions redistributing liquidity.

Figure 19.4 shows the average weekly pattern observed during the year 2013 of interactions among direct participants in SPEI<sup>®</sup>. We notice overall the behavior of direct participants is stable. We also observe that the actions taken by CI related to external funds usage are repetitive during the week. The black area at the bottom of Fig. 19.4 corresponds to externally financed obligations of CI—CBs and DBs. Those funds come from SIAC. Contrary, the external funds of NBFI flow from DALÍ, those funds are shown within a very thin brightest grey area. Next, direct participants’ internally financed obligations are presented in the upper part of the figure.

Figure 19.5 introduces the average monthly pattern of the external and internal funding dynamics of the participants. Here, with the exception of the second day of month, we observe externally financed payments of CI are relatively stable on average monthly basis. The volume of internally covered payments by CI exhibits a more variable pattern during the month, with the highest peak presented at the end. Finally, the volume of transactions that NBFI covered with incoming payments is stable on average at monthly basis.



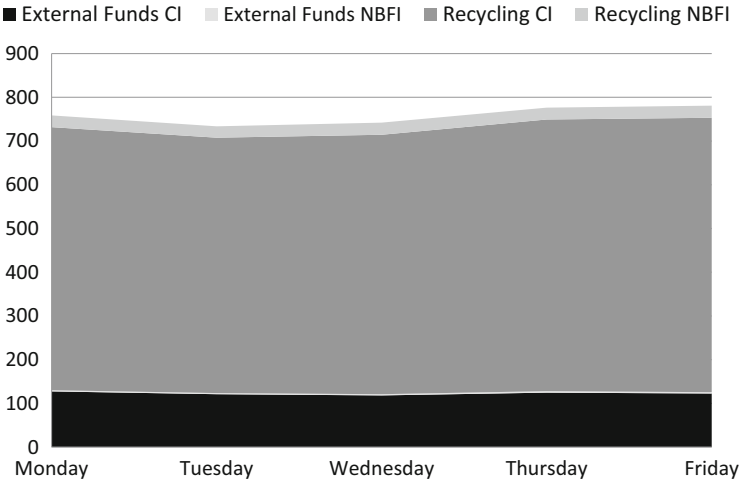


Fig. 19.4 Weekly pattern of funding vs. recycling per type of institutions

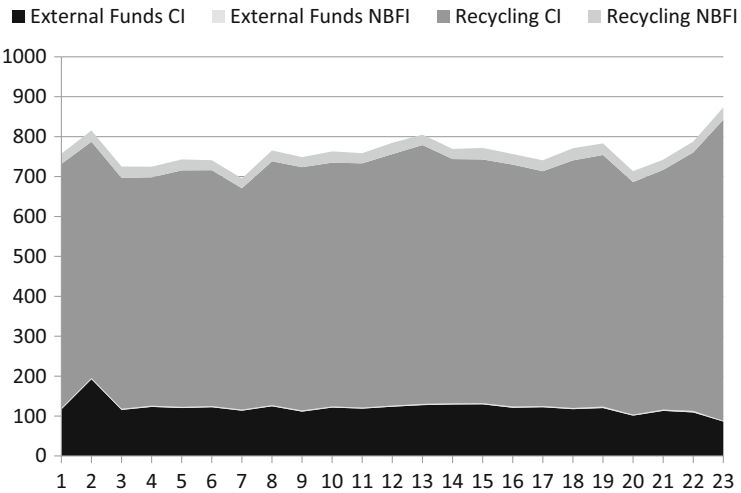


Fig. 19.5 Monthly pattern of funding vs. recycling per type of institutions

19.4 Summary and Conclusion

Liquidity issues have been one of the strongest lines of research for studies related to payment systems for over a decade now. This focus reveals the significant role of liquidity for the sound functioning of financial market infrastructures. The analysis in this paper contributes to this body of research. We presented an algorithm to study intraday payment flows in a system, in which around 91 % of the transactions correspond to retail payments. The algorithm separates funds transferred from other

FMI (or provided by a central bank) from the incoming payments from other participants used to cover obligations. The algorithm determines to what extent incoming payments are used to cover payment obligations. The framework of liquidity provision in the Mexican FMIs is used to evaluate the performance of the developed algorithm, with a particular focus on the high transaction volume processed by the LVPS. We found that despite the high presence of low value payments and considering all direct participants in SPEI, the settlement rules are efficient (see [16]). Nevertheless there is room for improvement if the volume of retail payments is expected to grow in the future and participants would like to keep the use of external funds in the lowest possible level. We recommend comparing the current settlement rules with alternative rules that include the possibility for higher volume of netting.

The algorithm provides information about the participants' behavior related to the use of incoming payments. However, the information about who initiates an operation (the participant or its client) is still missing from the algorithm. We need to evaluate to what extent payments initiated by a third party increase the demand on liquidity or help to reduce the pressure on it through recycling. In addition, we need to gain more insights into the mechanism for redistribution of funds among participants, by including the unsecured/secured lending transactions into the analytical framework from the perspective of systemic relevance analyzed in [14].

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